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BIOLOGICAL TREATMENT OF COMPOSITION B WASTEWATERS

I. ROTATING BIOLOGICAL CONTACTOR

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A pilot-scale rotating biological contactor (RBC) was used to treat wastewaters from explosives production at Holston Army Ammunition Plant. At hydraulic loadings up to the system maximum of 1.1 gal/min-ft^2, COD removals of 80 to 90 percent and BOD_5 removals of nearly 100 percent were achieved from late spring to mid-autumn, 1985. The RBC was able to accommodate abrupt changes in loading and temperature, but performance degraded substantially with the onset of prolonged cold weather in December 1985. Of the nitramines,

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20. Abstract (continued)

only TAX was significantly reduced by RBC treatment. These results generally support earlier RBC studies, which used high-strength synthetic wastewaters.

Keywords: environmental management; waste management; Hazardous materials

PREFACE

This research was performed under R&D Project No. 1L162720D048, US Army Toxic and Hazardous Materials Agency. Project Officer was Janet Mahannah. This study was part of the AMCCOM Pollution Abatement and Environmental Control Technology Program. High performance liquid chromatography analyses were performed at USAMBRDL by Ernst E. Brueggemann. Analytical support was provided by Holston Defense Corporation. Consultant for this project was Dr. Charles I. Noss, University of South Florida.

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INTRODUCTION

Composition B, an intimate mixture of 60.7 percent RDX (hexahydro-1,3,5-trinitrotriazine), 38.7 percent TNT (2,4,6-trinitrotoluene), and 0.8 percent wax binder, is the most extensively produced composite explosive in the inventory of the US Army.[1] The Army is presently contemplating construction of one or more new facilities for manufacture of RDX and HMX (octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine), an explosive and propellant. It is anticipated that the Bachmann process,[2] in which hexamine is treated with nitric acid and ammonium nitrate in the presence of acetic anhydride, will be utilized, and that process waters will be similar to those from Holston Army Ammunition Plant (HSAAP), presently the sole domestic source of RDX and HMX.[3] Although more than 50 products are manufactured at HSAAP, much of the RDX is combined with TNT, procured elsewhere, to make Composition B. During 1985, HSAAP treated an average of 5 mgd (1300 m^3/d) of combined wastewaters using fixed-film denitrification, activated sludge, and dual media filtration. (A primary sedimentation basin and trickling filter were available but not utilized.)

Although the Army is inclined to duplicate the HSAAP liquid waste treatment plant for the new facility (X-facility),[3] there are alternative biological treatment processes that may offer advantages in terms of energy consumption and ease of construction. In 1979-1980, independent bench and pilot-scale studies were carried out at Belvoir Research, Development and Engineering Center[4] (formerly MERADCOM) and Atlantic Research Corporation (ARC)[5] to evaluate the use of the aerobic rotating biological contactor (RBC) for treating anticipated X-facility wastewaters. In the present report, use of a pilot-scale RBC for treatment of authentic combined wastewaters at HSAAP is described, and results are compared with the earlier work on synthetic wastewaters.

EXPERIMENTAL PROCEDURE

EQUIPMENT

The experimental apparatus, a four-stage aerobic RBC manufactured by Environmental Systems Division of Geo. A. Hormel and Company, is identical to the unit employed by Kitchens et al.[5] Each stage has twelve 47-in (1.2 m) black, dimpled polyethylene disks (media) of 35 ft^2 (3.25 m^2) surface area, giving a total contactor area of 1,680 ft^2 (156 m^2) and a media volume of approximately 36 ft^3 (1.02 m^3). With 1-inch I.D. Tygon^R tubing, the feed was drawn by siphon from the neutralization basin of the HSAAP wastewater treatment plant, i.e., upstream of all treatment other than pH control. A bleed line from the tubing provided controlled influent to the RBC; effluent from the fourth stage of the RBC and excess feed were returned to the wastewater plant for treatment. The complete system is illustrated in Figures 1 and 2. During June and July 1985, and from 21 October through 20 December 1985, influent flow was maintained at 1.3 gal/min (4.9 L/min), the maximum hydraulic flow the RBC would accept; from 31 July through 21 October the influent flow was maintained at 0.5 gal/min (1.9 L/min), the lower end of the

Figure 1. Experimental Apparatus, Side View.

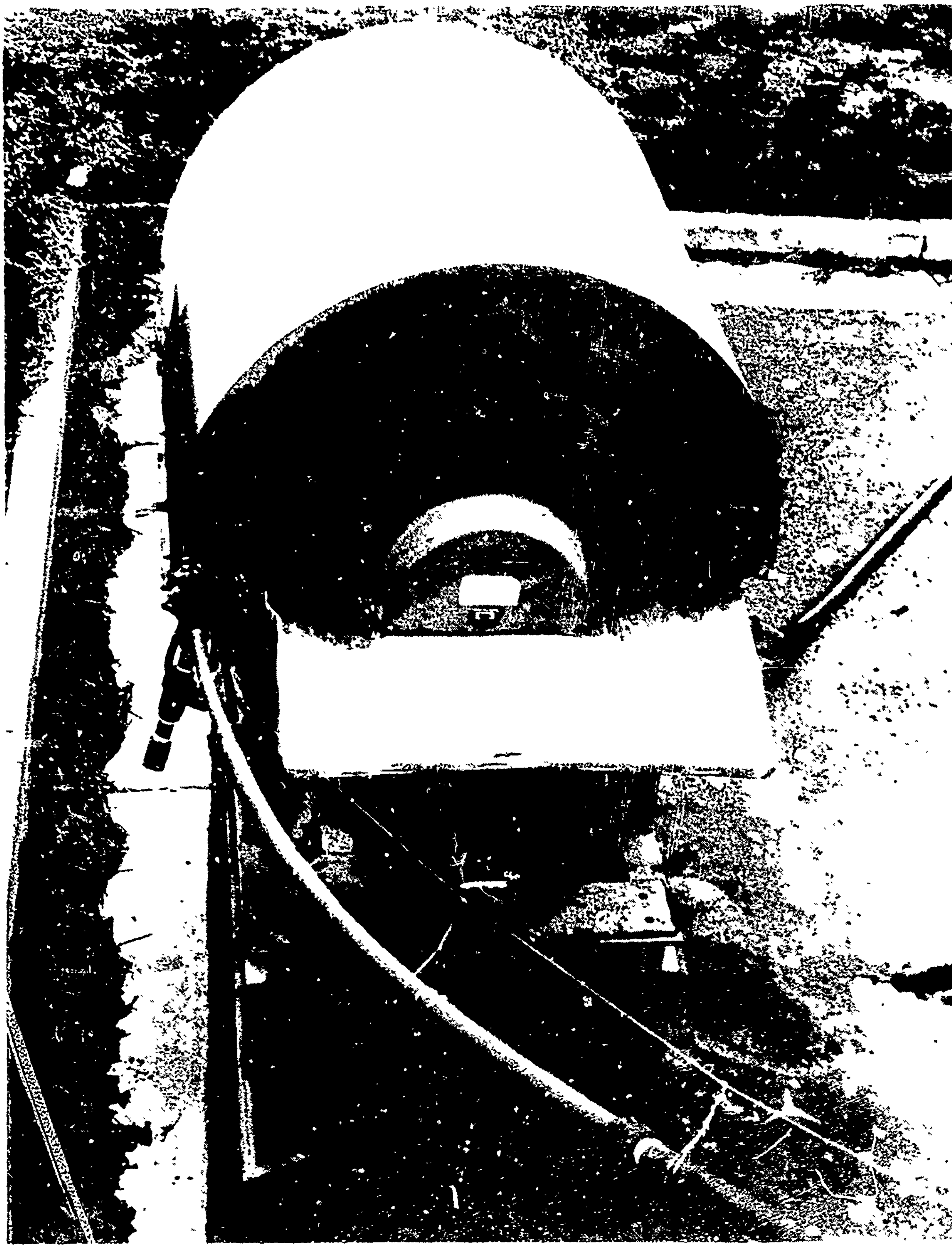

Figure 2. Experimental Apparatus, End View.

'raulic regime for this system. Disk immersion was approximately 40 percent, and rotational speed was controlled at 4 rpm, for a peripheral velocity of 49 ft/min (0.23 m/sec), throughout the study. Frequent cleaning of influent and effluent lines, as well as ports between stages, was necessary to prevent biomass plugging. Disks did not appear to be overloaded.

ANALYSES

Samples were generally collected between 0800 and 0900 hours. Analyses for RDX, HMX, TAX (1-acetylhexahydro-3,5-dinitrotriazine), and SEX (1-acetyloctahydro-3,5,7-trinitrotetrazocine) were performed by high performance liquid chromatography (HPLC) as described by Brueggemann.[6] Analysis of neutralization basin influent for TNT, a potential component of Composition B wastewaters, was also performed by HPLC; none was detected above a level of 0.05 mg/L. Chemical oxygen demand (COD) was determined according to Standard Methods.[7] Dissolved oxygen content (DO) and pH were measured using Corning electrodes. Five-day biochemical oxygen demand (BOD), total Kjeldahl nitrogen (TKN), and total phosphorus were determined by Tri-State Analytical Laboratory, Kingsport, TN. BOD and COD were determined from settled samples.

RESULTS AND DISCUSSION

The RBC pilot unit was installed at HSAAP in late May 1985, and operated continuously through 19 December, when the equipment was immobilized by a hard freeze. Three performance periods were established as defined by loading rates (Table 1). Hydraulic and organic loading rates generally fell within or close to ranges recommended by the US Environmental Protection Agency (0.75-1.5 gal/day-ft^2 and 30-60 lb BOD_5/day-1,000 ft^3, respectively).[8] Operational data for all three periods are compiled in Appendix A, Table A-1.

TABLE 1. OPERATIONAL PARAMETERS

Parameter	5 Jun - 31 Jul	31 Jul - 21 Oct	21 Oct - 19 Dec
Flow, gal/min	1.3	0.5	1.3
L/min	4.9	1.9	4.9
Hydraulic loading,			
gal/day-ft^2	1.1	0.4	1.1
L/day-m^2	45	18	45
Organic loading,			
lb BOD/day-1000ft^3	Not	30	69
Kg BOD/day-m^3	Measured	0 48	1.11
lb COD/day-1000ft^3	111	48	126
Kg COD/day-m^3	1.79	0.76	2.02

RBC Performance with Respect to Conventional Parameters

Within 2 weeks of startup, performance of the RBC had largely stabilized, with COD removal between 80 and 90 percent (Table 2 and Figure 3). During the second period, with lower hydraulic and organic loadings, COD removal was slightly higher, and BOD removal was close to 100 percent (Table 2 and Figures 4-6). During the autumn period, with higher hydraulic and organic loadings, average BOD removal fell off somewhat, mainly due to the drop in performance that accompanied the onset of cold weather at the end of this period (Table 2 and Figures 6-8). Total phosphorus, ammonia, and total Kjeldahl nitrogen (TKN) were all at fairly low levels in the influent and were not substantially altered by RBC treatment. Abrupt changes in loading at the end of the first and second periods were accompanied by mild upsets, as will be discussed below, but performance was not notably degraded. Complete performance data are listed in Table A-2. (Influent nitrate levels, measured by Holston Defense Corporation but not reported here, were high and variable during the study period, most commonly ranging from 10 to 40 mg/L as NO_3-N.)

TABLE 2. WASTEWATER TREATMENT PARAMETERS

Parameter	Period: 5 Jun - 31 Jul mg/L ± s.d. (n)	31 Jul - 21 Oct mg/L ± s.d. (n)	21 Oct - 19 Dec mg/L ± s.d. (n)
COD infl	257 ± 56 (23)	286 ± 70 (43)	290 ± 91 (21)
effl	48 ± 31 (23)	36 ± 18 (42)	42 ± 35 (21)
BOD infl	Not	178 ± 54 (22)	159 ± 47 (13)
effl	Measured	4 ± 7 (19)	9 ± 9 (13)
Total P infl	Not	0.81 ± .59 (22)	0.50 ± .50 (13)
effl	Measured	0.78 ± .58 (20)	0.45 ± .34 (13)
TKN infl	Not	5.9 ± 3.1 (22)	6.2 ± 4.0 (13)
effl	Measured	4.1 ± 2.8 (20)	5.3 ± 3.7 (13)
NH_3 infl	1.36 ± 1.65 (21)	0.39 ± .36 (39)	0.56 ± .76 (16)
effl	0.50 ± .15 (19)	0.29 ± .12 (38)	0.85 ± .48 (16)

Operational data for each stage of the RBC are presented in Table A-1, and performance data are presented in Table A-2. For the first two periods, the dissolved oxygen (DO) levels increased from the first through the fourth stages, indicating that the first stage was carrying most of the burden for removal of organics. At no time did DO levels fall below 2 mg/L in the first stage, indicating that the first stage was not overburdened. With the onset of cold weather in October, however, minimum DO levels shifted to later stages and occasionally fell below 1 mg/L. Two explanations for this behavior are

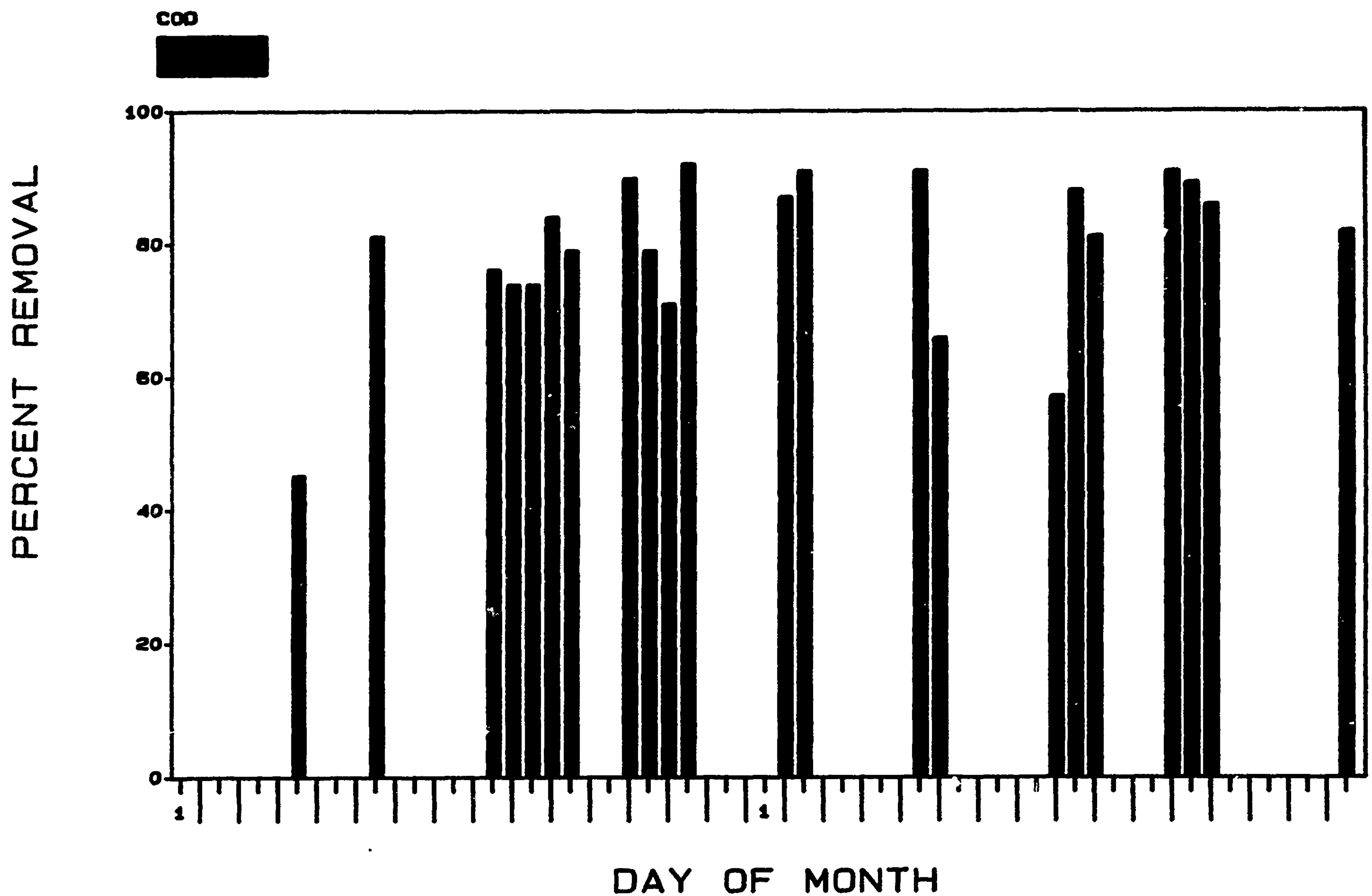

Figure 3. COD Removal: 1 June 85 to 31 July 1985.

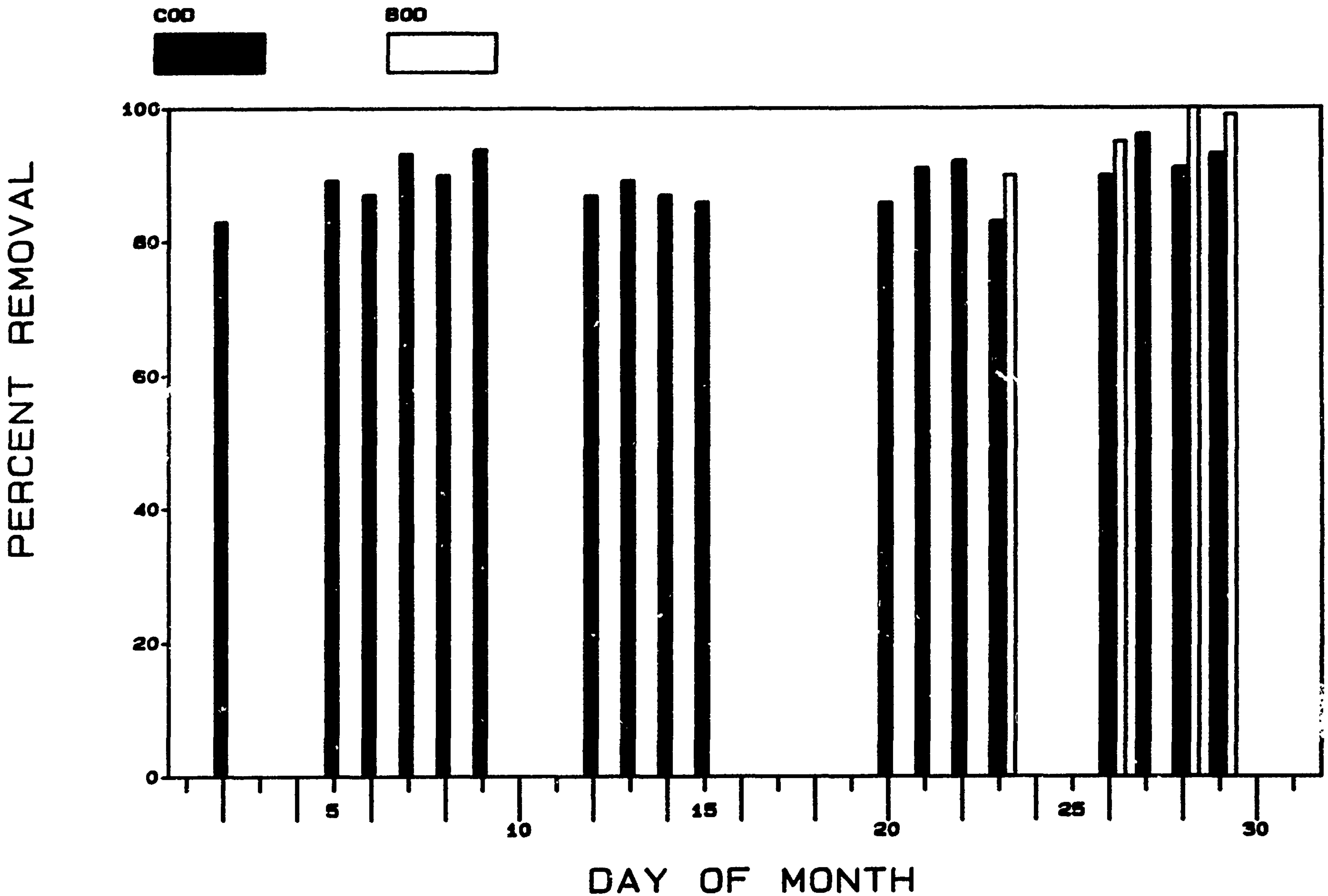

Figure 4. COD and BOD Removals: August 1985.

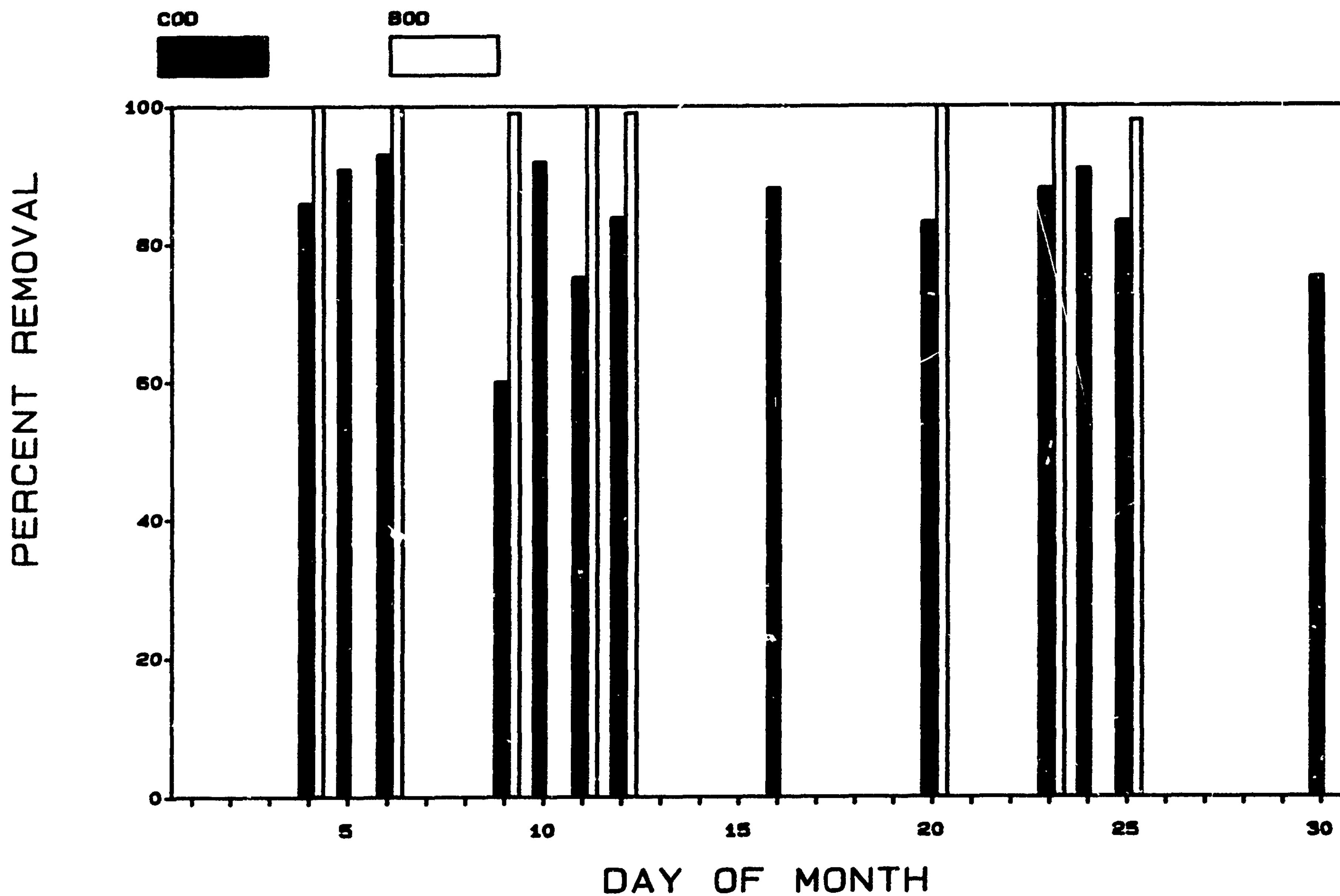

Figure 5. COD and BOD Removals: September 1985.

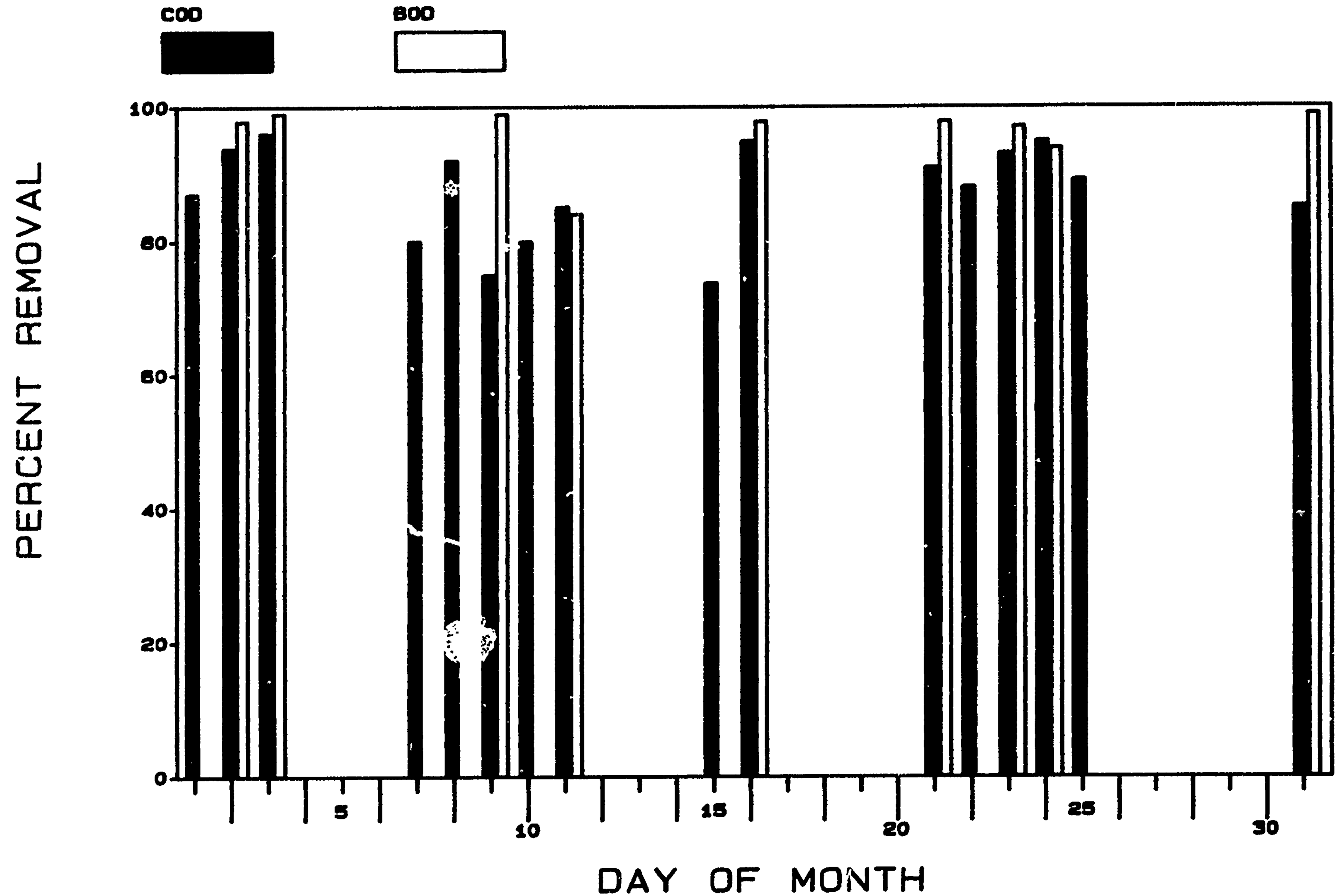

Figure 6. COD and BOD Removals: October 1985.

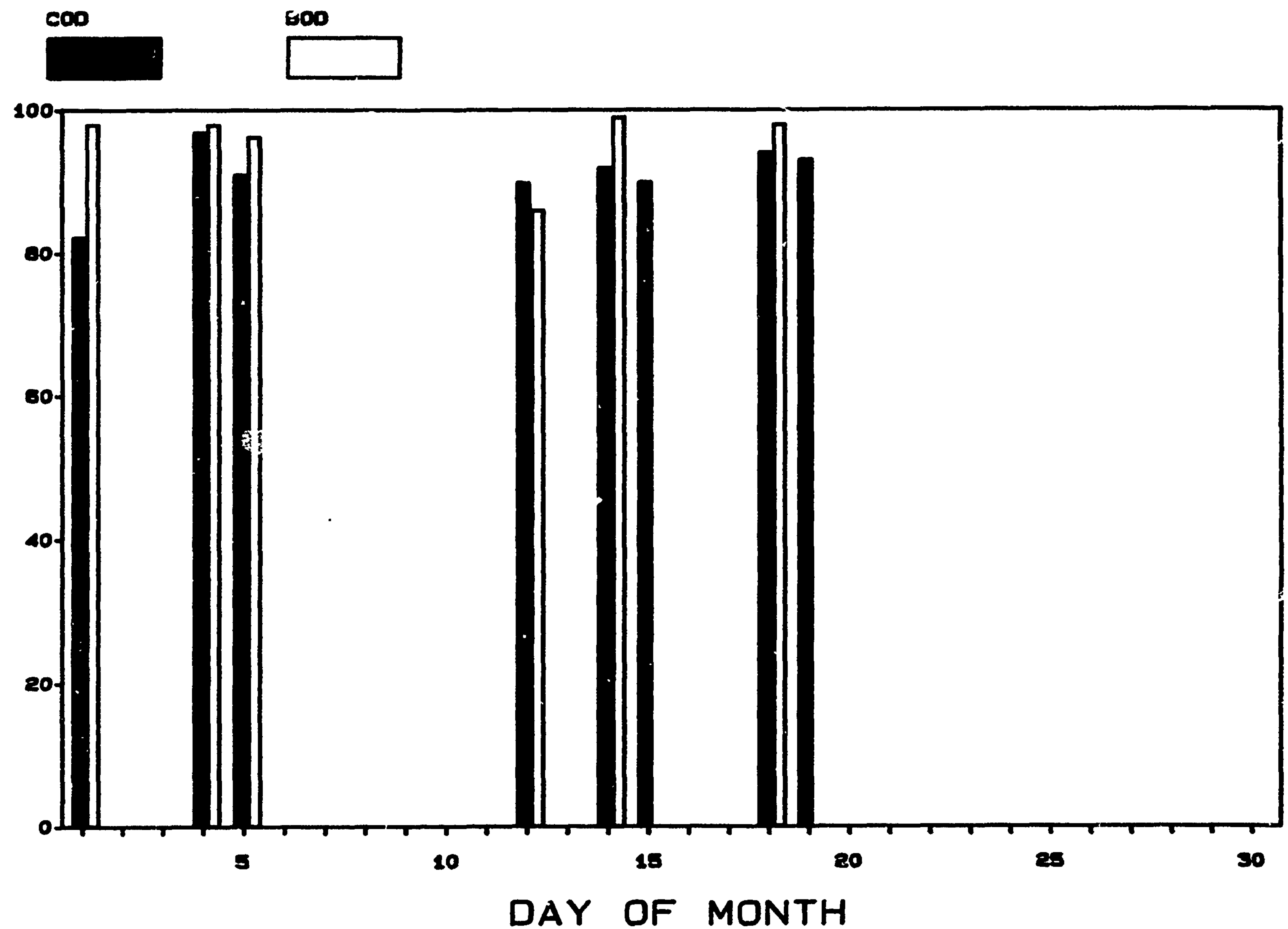

Figure 7. COD and BOD Removals: November 1985.

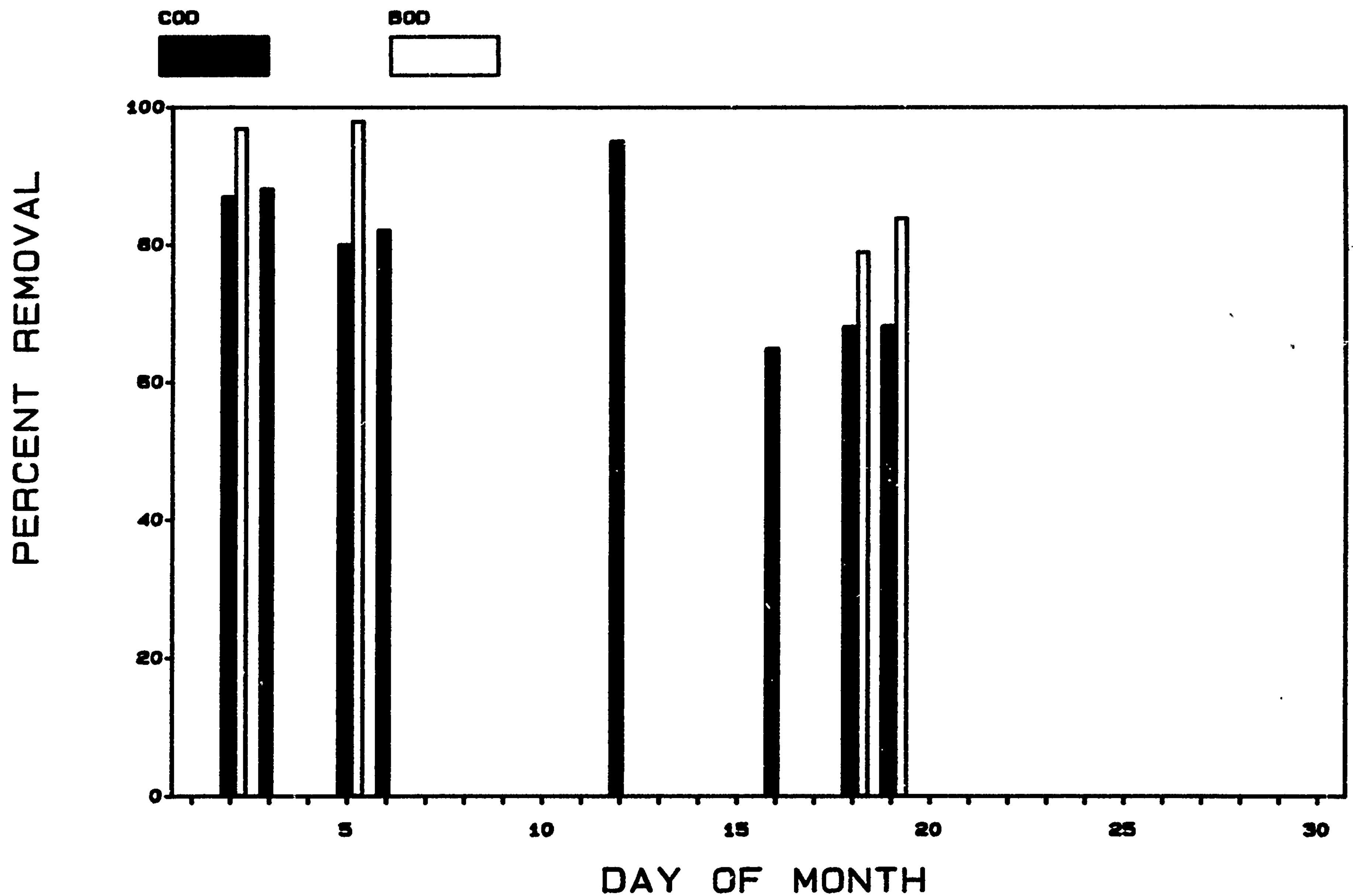

Figure 8. COD and BOD Removals: December 1985.

(1) cold temperatures reduced the rate of reaction in the first stage, placing a greater organic burden on subsequent stages, and (2) temperature stress resulted in sloughing of biomass from the first stage, placing an additional organic burden on subsequent stages. We prefer the second explanation because average water temperature changes (in contrast to air temperature changes) were too small to account for a significant rate change. Sloughing of biomass in response to stress is a well-documented RBC phenomenon; in these studies it was observed when hydraulic and organic loadings were changed abruptly at the end of the first and second periods.

Changes in pH were more subtle but generally followed the pattern established by DO levels. The influent pH was highly variable but tended to drop in the first stage, as would be expected, since organic material was being converted to carbon dioxide. The pH increased in subsequent stages as carbon dioxide was lost to the atmosphere. With the onset of cold weather the pH minimum shifted to later stages, either because biooxidation had shifted or because carbon dioxide diffusion to the atmosphere was less efficient. At no time did the influent pH approach a level of 3, found by Chesler and Eskelund to inhibit startup.[4]

A sharp drop in influent temperature occurred during the first week in December; this was followed 2 weeks later by substantial degradation in performance. Kitchens et al.[5] observed an abrupt drop in performance with respect to removal of organics below 10°C; performance of our system began to degrade at about 15°C. We were unable to sustain operation of our system long enough to determine if recovery could be effected below 15°C.

Removal of Nitramines

Influent and effluent analyses for RDX, HMX, TAX, and SEX are presented in Table A-3. During the first test period, each RBC stage was sampled on several occasions. For all nitramines except TAX, concentrations dropped sharply the influent to the first stage, then rose successively through succeed- ges. RDX exhibited a modest overall reduction, while HMX and SEX actu- showed a net increase in many cases. TAX, to the contrary, continued to diminish in concentration through each succeeding stage and dropped below detection limits during the summer months. Our interpretation of these results is that the nitramines tend to be adsorbed onto or absorbed into the biomass in the first stage. As the biomass is sloughed off from the first stage and degraded in subsequent stages, the nitramines are released back into solution, except for TAX, which has been biodegraded somewhere in the process. The net increase, noted in particular for HMX in the colder months, probably results from degradation of nitramine-containing suspended organic material in the influent stream. (The volatile suspended solids content of the influent averages 20-30 mg/L.)

Comparison of USAMBRDL, MERADCOM, and ARC Results

Chesler and Eskelund[4] and Kitchens et al.[5] based their studies on the much more concentrated wastestreams anticipated by ARRADCOM (now Army Armament Research, Development and Engineering Center) for X-facility. Components of the basic synthetic wastewater, also used by Bell et al. in studies of the semicontinuous activated sludge system,[9] are listed in Table A-4. Wastewater characteristics and loading rates for the earlier studies are listed in Table 3. The more dilute of the two streams in this table, Wastewater 1 (Table A-4), includes 35 percent heat exchanger condensate.

TABLE 3. CHARACTERISTICS AND LOADING RATES FOR SYNTHETIC WASTEWATERS

Parameter	Wastewater 1		Wastewater 2	
	MERADCOM	ARC	MERADCOM	ARC
BOD_5, mg/L	1390	1187	2150[a]	1840
COD, mg/L	1650		2560[a]	
Hydraulic loading,[b]				
gal/day-ft^2	0.10-.37	0.24-.27	0.11-.26	0.12-.15
L/day-m^2	4.0-15.6	9.7-10.9	4.6-10.9	4.9-6.1
Organic loading,[b,c]				
lb BOD/day-1000ft^3	Not	110-124	Not	85-107
Kg BOD/day-m^3	Measured	1.76-1.98	Measured	1.37-1.71

a. Calculated from authors' data.
b. After startup.
c. Media density unavailable from Reference 4.

It is seen that hydraulic loadings for the MERADCOM and ARC studies were well below those used in the present work, and organic loadings were well above; both, in fact, were well outside the ranges recommended by EPA.[8] Nevertheless, generally satisfactory, if variable, results were obtained with both systems. The MERADCOM reactor, a small benchtop unit with 10.25 in (26 cm) disks, generally gave 80 ± 10 percent COD removal from Wastewater 1 under an average area loading of 2.3 to 3.6 lb/day-1,000 ft^2 (corresponding to a hydraulic loading of 0.17 to 0.26 gal/day-ft^2) and 60 ± 10 percent COD removal from Wastewater 2 under an average loading of 2.3 lb/day-1,000 ft^2 (corresponding to a hydraulic loading of about 0.11 gal/day-ft^2).[4] MERADCOM observed negligible removal of RDX and HMX from the influent.

For the ARC reactor, which is identical to the USAMBRDL unit, operating conditions were never stabilized long enough to determine steady-state removal efficiencies for Wastewater 1. A chronic dissolved oxygen deficiency in the first stage during summer months was corrected by splitting the influent equally to the first two stages. The authors suggest that an area loading of

2.0 to 2.2 lb BOD/day-1,000 ft^2 (corresponding to a hydraulic loading of 0.20 to 0.22 gal/day-ft^2 for Wastewater 1 and 0.13 to 0.14 gal/day-ft^2 for Wastewater 2 and a volumetric loading of 93 to 103 lb/day-ft^3 for either stream) should give 95 to 100 percent BOD removal.[5] This performance was never consistently achieved for Wastewater 1, but was achieved for nearly a month with Wastewater 2, before cold weather dropped influent temperatures below 10°C. The authors also state that the area loading should not exceed 2.5 lb BOD/day-1,000 ft^2 (117 lb/day-1,000 ft^3) in order to avoid an oxygen deficiency in the first stage. It is of interest that dissolved oxygen levels, once stabilized, were consistently higher in all stages for Wastewater 2 than for Wastewater 1, irrespective of loading. This may have been due to cooler influent temperatures for Wastewater 2.[5]

CONCLUSIONS

1. The rotating biological contactor is capable of treating present HSAAP wastewaters for removal of BOD_5 to discharge standards. The unit used in the present USAMBRDL studies was underloaded, and it is safe to assume that the most severe water conservation practices at HSAAP would not degrade performance at the maximum hydraulic loading, i.e., 1.1 gal/day-ft^2 (45 L/day-m^2). Under conditions studied at HSAAP, the RBC proved capable of accommodating substantial loading variations.

2. The RBC is capable of treating high-strength wastewaters anticipated for X-facility but, as pointed out by Chesler and Eskelund,[4] 95 percent BOD removal may not meet reasonable discharge standards. Additional treatment will likely be required (see below).

3. The heaviest burden for degradation of organic materials and hence the most severe oxygen deprivation falls to the first stage of the RBC. The practice of Kitchens et al.[5] of splitting feed to go to the first two stages is commended.

4. RBC performance is adversely affected by temperatures significantly below 15°C. For geographical regions such as eastern Tennessee, it would be necessary to house all units to reduce heat loss.

5. The RBC is capable of reducing TAX to detection limits, but reductions in the levels of other nitramines are modest to insignificant.

RECOMMENDATIONS

1. Design criteria for any RBC installation should be developed with full-sized disks, i.e., at least 12 ft (3.66 m) in diameter.

2. The RBC does not constitute a single solution for RDX/HMX production wastewaters since it does not provide for nitrate removal. It is recommended that denitrification by means of a high-flow, completely submerged RBC be investigated. Such treatment would substantially reduce the BOD loading on the aerobic unit, and might effect a significant reduction in nitramines as well. For discussion of the anaerobic RBC, see Laquidara et al.[10]

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APPENDIX A

PERFORMANCE AND OPERATIONAL DATA

TABLE A-1. OPERATIONAL DATA

Date	Sample Point	Temperature ^{o}C	DO mg/L	pH	Flow gal/min
5 Jun	Influent	27.4	4.00	8.98	1.3
	Stage 1	26.1	9.48	8.00	1.3
	2	26.3	6.02	8.03	1.3
	3	26.5	7.65	8.02	1.3
	4	26.4	7.89	8.25	1.3
6 Jun	Influent	27.6	3.7	9.0	1.3
	Stage 1	27.2		7.74	1.3
	2	26.9		8.02	1.3
	3	26.0		8.20	1.3
	4	25.5		8.27	1.3
7 Jun	Influent	25.0	3.02	9.3	1.3
	Stage 1	24.4	3.32	7.52	1.3
	2	23.6	6.20	7.94	1.3
	3	23.2	8.30	8.12	1.3
	4	22.1	8.77	8.20	1.3
11 Jun	Influent	26.1	3.91	6.67	1.3
	Stage 1	25.7	6.92	7.52	1.3
	2	24.9	8.87	7.81	1.3
	3	24.4	9.4	7.81	1.3
	4	24.1	9.5	7.89	1.3
12 Jun	Influent	23.6	3.73	6.66	1.3
	Stage 1	21.9	7.42	7.2	1.3
	2	21.1	8.95	7.51	1.3
	3	20.4	9.18	7.57	1.3
	4	20.1	9.58	7.65	1.3
13 Jun	Influent	19.5	3.88	8.62	1.3
	Stage 1	18.1	7.28	7.56	1.3
	2	17.1	8.72	7.71	1.3
	3	15.7	9.86	7.65	1.3
	4	13.9	10.23	7.81	1.3
14 Jun	Influent	24	4.2	7.65	1.3
	Stage 1	18.8	6.55	7.52	1.3
	2	18.0	8.70	7.83	1.3
	3	16.8	9.55	7.93	1.3
	4	16.2	10.06	7.98	1.3

Table A-1 continued

Date	Sample Point	Temperature °C	DO mg/L	pH	Flow gal/min
17 Jun	Influent	27.0	2.07	6.55	1.3
	Stage 1	27.1	4.55	7.5	1.3
	2	26.5	5.74	7.72	1.3
	3	26.2	7.27	7.92	1.3
	4	26.0	7.89	8.03	1.3
18 Jun	Influent	26.2	0.15	6.55	1.3
	Stage 1	25.2	3.32	7.48	1.3
	2	24.8	4.69	7.51	1.3
	3	24.0	6.52	7.79	1.3
	4	23.2	7.85	7.91	1.3
19 Jun	Influent	26.4	0.52	7.09	1.3
	Stage 1	25.1	2.35	7.66	1.3
	2	23.5	4.10	7.73	1.3
	3	22.4	7.11	7.87	1.3
	4	21.2	8.63	8.00	1.3
25 Jun	Influent	25.7	0.67	6.85	1.3
	Stage 1	23.8	4.0	7.73	1.3
	2	23.2	6.9	7.91	1.3
	3	22.9	8.37	8.17	1.3
	4	22.4	8.98	8.27	1.3
26 Jun	Influent	27.6	1.65	8.95	1.3
	Stage 1	27.2	3.33	7.73	1.3
	2	27.5	4.54	7.73	1.3
	3	27.3	7.22	8.01	1.3
	4	27.1	8.25	8.20	1.3
27 Jun	Influent	25	2.01	6.48	1.3
	Stage 1	23	3.77	7.21	1.3
	2	23.3	5.32	7.25	1.3
	3	22.5	8.05	7.82	1.3
	4	22.1	8.75	8.06	1.3
2 Jul	Influent	24.6	2.42	8.60	1.3
	Stage 1	23.0	5.0	7.48	1.3
	2	22.1	6.84	7.65	1.3
	3	21.5	8.88	8.11	1.3
	4	20.9	9.64	8.23	1.3
3 Jul	Influent	25.0	1.32	6.55	1.3
	Stage 1	23.8	3.45	7.35	1.3
	2	23.4	4.36	7.56	1.3
	3	22.9	7.70	8.08	1.3
	4	22.6	8.53	8.31	1.3

Table A-1 continued

Date	Sample Point	Temperature °C	DO mg/L	pH	Flow gal/min
8 Jul	Influent	25.1	2.22	6.62	1.3
	Stage 1	24.6	4.82	7.53	1.3
	2	24.1	5.89	7.62	1.3
	3	23.3	8.06	7.83	1.3
	4	22.5	8.95	7.96	1.3
9 Jul	Influent	27.0	2.26	8.51	1.3
	Stage 1	27.1	2.24	7.7	1.3
	2	26.7	4.3	7.81	1.3
	3	26.1	7.21	8.11	1.3
	4	25.9	7.91	8.28	1.3
16 Jul	Influent	26.5	1.1	6.85	1.3
	Stage 1	25.2	4.64	7.6	1.3
	2	25.8	4.62	7.58	1.3
	3	25.8	6.00	7.90	1.3
	4	25.7	6.43	7.96	1.3
17 Jul	Influent	26.0	1.20	7.08	1.3
	Stage 1	24.6	3.20	7.65	1.3
	2	24.7	5.66	7.81	1.3
	3	24.1	8.06	8.15	1.3
	4	23.6	8.62	8.30	1.3
18 Jul	Influent	26.2	1.42	7.12	1.3
	Stage 1	25.6	3.08	7.53	1.3
	2	25.5	4.36	7.61	1.3
	3	25.1	7.81	8.00	1.3
	4	24.5	8.81	8.16	1.3
22 Jul	Influent	25.6	1.63	6.73	1.3
	Stage 1	25.5	2.85	7.29	1.3
	2	25.6	4.24	7.35	1.3
	3	25.3	6.97	7.68	1.3
	4	24.9	7.89	7.92	1.3
23 Jul	Influent	25.6	2.23	9.15	1.3
	Stage 1	25.7	4.20	7.79	1.3
	2	25.5	6.27	7.83	1.3
	3	25.3	7.47	7.93	1.3
	4	25.1	8.22	8.06	1.3

Table A-1 continued

Date	Sample Point	Temperature °C	DO mg/L	pH	Flow gal/min
24 Jul	Influent	25.4	1.22	6.67	1.3
	Stage 1	23.8	6.97	7.73	1.3
	2	23.5	8.70	7.68	1.3
	3	23.2	9.30	7.76	1.3
	4	22.7	9.40	7.83	1.3
31 Jul	Influent	27.0	2.50	7.77	1.3
	Stage 1	27.1	5.61	7.93	1.3
	2	26.8	7.17	7.96	1.3
	3	26.4	8.45	8.08	1.3
	4	26.7	8.86	8.21	1.3
2 Aug	Influent	24.0	2.12	6.14	0.5
	Stage 1	23.6	2.71	7.05	0.5
	2	23.6	4.48	7.13	0.5
	3	23.4	7.28	7.45	0.5
	4	23.0	8.37	7.77	0.5
5 Aug	Influent	25.0	2.24	9.43	0.5
	Stage 1	25.5	5.14	7.87	0.5
	2	24.9	5.60	7.87	0.5
	3	23.4	8.47	8.04	0.5
	4	23.1	9.40	8.24	0.5
6 Aug	Influent	23.5	4.10	10.05	0.5
	Stage 1	22.6	6.34	8.15	0.5
	2	22.6	6.87	8.08	0.5
	3	22.3	8.64	7.98	0.5
	4	21.8	9.23	8.13	0.5
7 Aug	Influent	23.5	4.09	6.87	0.5
	Stage 1	23.2	6.48	7.52	0.5
	2	23.0	6.99	7.57	0.5
	3	22.7	8.76	7.85	0.5
	4	22.4	8.99	8.01	0.5
8 Aug	Influent	23.6	4.02	7.01	0.5
	Stage 1	23.7	4.07	7.72	0.5
	2	23.5	5.10	7.78	0.5
	3	23.3	8.02	8.11	0.5
	4	22.8	8.66	8.31	0.5
9 Aug	Influent	25.2	3.35	8.16	0.5
	Stage 1	26.2	4.28	7.80	0.5
	2	24.8	6.09	7.85	0.5
	3	24.5	8.18	8.00	0.5
	4	24.0	8.78	8.15	0.5

Table A-1 continued

Date	Sample Point	Temperature °C	DO mg/L	pH	Flow gal/min
12 Aug	Influent	26.0	3.87	6.54	0.5
	Stage 1	25.7	2.94	7.56	0.5
	2	25.5	4.06	7.62	0.5
	3	25.2	6.88	7.85	0.5
	4	24.9	8.28	8.09	0.5
13 Aug	Influent	25.4	3.78	9.15	0.5
	Stage 1	24.5	3.70	7.45	0.5
	2	23.8	5.01	7.55	0.5
	3	23.1	7.98	7.78	0.5
	4	22.7	8.80	7.92	0.5
14 Aug	Influent	25.7	2.95	6.68	0.5
	Stage 1	25.7	2.46	7.33	0.5
	2	25.4	4.41	7.46	0.5
	3	25.0	7.54	7.84	0.5
	4	24.6	8.47	8.05	0.5
15 Aug	Influent	28.3	3.27	11.01	0.5
	Stage 1	27.6	2.87	7.91	0.5
	2	27.0	4.50	8.45	0.5
	3	26.5	6.79	8.01	0.5
	4	26.5	7.92	8.03	0.5
20 Aug	Influent	25.5	3.12	7.21	0.5
	Stage 1	25.6	5.23	7.43	0.5
	2	25.2	5.94	7.52	0.5
	3	24.9	7.69	7.60	0.5
	4	24.5	8.29	7.65	0.5
21 Aug	Influent	24.0	3.51	7.41	0.5
	Stage 1	24.0	4.86	7.23	0.5
	2	23.9	5.67	7.33	0.5
	3	23.4	8.04	7.53	0.5
	4	23.2	8.74	7.85	0.5
22 Aug	Influent	23.4	4.94	7.32	0.5
	Stage 1	22.3	6.72	6.92	0.5
	2	21.9	6.58	7.17	0.5
	3	21.2	8.75	7.57	0.5
	4	21.0	9.15	7.89	0.5
23 Aug	Influent	20.1	4.09	9.48	0.5
	Stage 1	20.6	5.56	7.51	0.5
	2	20.3	5.93	7.48	0.5
	3	19.5	8.38	7.52	0.5
	4	18.6	9.01	7.62	0.5

Table A-1 continued

Date	Sample Point	Temperature °C	DO mg/L	pH	Flow gal/min
26 Aug	Influent	24.0	5.40	7.20	0.5
	Stage 1	23.7	6.00	7.13	0.5
	2	23.1	7.31	7.23	0.5
	3	22.6	8.93	7.35	0.5
	4	22.5	9.08	7.58	0.5
27 Aug	Influent	23.7	5.11	7.16	0.5
	Stage 1	23.4	5.95	7.06	0.5
	2	23.1	7.35	7.24	0.5
	3	22.7	8.65	7.41	0.5
	4	22.6	8.95	7.56	0.5
28 Aug	Influent	24.0	4.94	7.42	0.5
	Stage 1	22.5	6.48	7.11	0.5
	2	22.3	7.16	7.26	0.5
	3	22.1	8.92	7.42	0.5
	4	22.1	9.14	7.60	0.5
4 Sep	Influent	25.9	0.87	7.40	0.5
	Stage 1	24.9	3.12	6.61	0.5
	2	24.9	4.24	6.75	0.5
	3	24.8	6.38	6.95	0.5
	4	25.1	7.00	7.25	0.5
5 Sep	Influent	26.4	2.30	8.35	0.5
	Stage 1	26.5	4.60	6.71	0.5
	2	26.1	5.65	6.87	0.5
	3	25.6	7.13	6.99	0.5
	4	26.0	7.47	7.15	0.5
6 Sep	Influent	24.8	3.62	9.82	0.5
	Stage 1	24.9	2.01	7.16	0.5
	2	24.7	4.29	7.27	0.5
	3	24.3	6.15	7.38	0.5
	4	23.9	6.98	7.50	0.5
9 Sep	Influent	25.3	4.07	7.19	0.5
	Stage 1	25.1	3.53	6.80	0.5
	2	24.8	4.74	6.93	0.5
	3	24.3	6.50	7.05	0.5
	4	24.0	7.15	7.16	0.5
10 Sep	Influent	25.1	3.85	7.40	0.5
	Stage 1	25.2	2.74	6.81	0.5
	2	25.1	3.88	6.94	0.5
	3	24.7	6.17	7.32	0.5
	4	24.5	7.23	7.52	0.5

Table A-1 continued

Date	Sample Point	Temperature °C	DO mg/L	pH	Flow gal/min
11 Sep	Influent	25.4	6.5	9.43	0.5
	Stage 1	24.9	4.50	6.90	0.5
	2	24.6	5.41	7.18	0.5
	3	23.9	7.71	7.34	0.5
	4	23.6	8.41	7.48	0.5
16 Sep	Influent	22.6	4.00	7.35	0.5
	Stage 1	20.9	4.50	6.90	0.5
	2	20.2	5.92	7.02	0.5
	3	19.6	6.93	7.15	0.5
	4	20.2	7.29	7.42	0.5
20 Sep	Influent	22.6	2.63	9.06	0.5
	Stage 1	22.0	3.19	7.72	0.5
	2	21.6	4.66	7.81	0.5
	3	21.0	7.15	7.89	0.5
	4	21.0	7.75	7.98	0.5
23 Sep	Influent	25.7	2.22	7.51	0.5
	Stage 1	24.1	2.99	7.10	0.5
	2	23.8	4.35	7.18	0.5
	3	23.7	6.84	7.26	0.5
	4	24.4	6.77	7.36	0.5
24 Sep	Influent	22.0	2.74	7.23	0.5
	Stage 1	21.0	5.20	6.92	0.5
	2	20.1	6.22	6.99	0.5
	3	20.0	7.54	7.12	0.5
	4	19.8	7.77	7.35	0.5
1 Oct	Influent	22.5	2.19	7.25	0.5
	Stage 1	21.7	2.75	7.09	0.5
	2	21.3	3.18	7.08	0.5
	3	20.9	3.75	7.25	0.5
	4	20.8	4.35	7.36	0.5
7 Oct	Influent	17.8	2.95	7.04	0.5
	Stage 1	12.2	5.40	7.52	0.5
	2	11.1	3.96	7.45	0.5
	3	9.8	3.26	7.29	0.5
	4	9.5	2.86	7.17	0.5

Table A-1 continued

Date	Sample Point	Temperature °C	DO mg/L	pH	Flow gal/min
9 Oct	Influent	22.4	1.06	6.97	0.5
	Stage 1	21.3	1.70	7.06	0.5
	2	20.6	1.52	6.99	0.5
	3	20.1	1.46	6.99	0.5
	4	19.9	1.39	7.06	0.5
11 Oct	Influent	24.0	2.4	7.40	0.5
	Stage 1	23.4	2.02	6.87	0.5
	2	23.3	1.67	6.93	0.5
	3	23.0	2.72	7.25	0.5
	4	23.9	2.73	7.52	0.5
21 Oct	Influent			6.79	0.5
	Stage 1			6.75	0.5
	2			6.72	0.5
	3			6.65	0.5
	4			6.73	0.5
22 Oct	Influent	21.4	1.47	7.25	1.3
	Stage 1	21.5	3.42	6.68	1.3
	2	20.9	3.01	6.82	1.3
	3	20.4	2.97	6.95	1.3
	4	20.2	2.39	7.01	1.3
24 Oct	Influent	25.1	1.47	7.85	1.3
	Stage 1	23.4	3.54	7.54	1.3
	2	23.3	2.74	7.43	1.3
	3	23.1	2.40	7.46	1.3
	4	22.9	2.47	7.50	1.3
25 Oct	Influent	23.7	1.16	6.96	1.3
	Stage 1	23.3	0.84	7.81	1.3
	2	23.2	1.04	8.22	1.3
	3	22.9	1.14	8.26	1.3
	4	22.9	1.68	8.19	1.3
31 Oct	Influent	21.5	1.5	6.88	1.3
	Stage 1	22.7	0.77	7.33	1.3
	2	22.1	3.92	7.60	1.3
	3	21.0	5.48	7.81	1.3
	4	19.9	6.01	7.95	1.3
1 Nov	Influent	22	4.30	6.78	1.3
	Stage 1	20.6	3.80	7.5	1.3
	2	20.8	6.37	7.84	1.3
	3	20.4	7.51	8.07	1.3
	4	20.9	8.10	8.29	1.3

Table A-1 continued

Date	Sample Point	Temperature °C	DO mg/L	pH	Flow gal/min
4 Nov	Influent	19.1	1.52	9.46	1.3
	Stage 1	18.7	1.82	7.55	1.3
	2	18.1	3.65	7.43	1.3
	3	16.6	5.55	7.53	1.3
	4	15.2	7.48	7.80	1.3
12 Nov	Influent	21.0	1.90	8.83	1.3
	Stage 1	21.3	0.80	7.78	1.3
	2	21.3	0.52	7.67	1.3
	3	21.1	3.24	7.85	1.3
	4	20.9	5.69	7.99	1.3
18 Nov	Influent	22.3	1.30	6.76	1.3
	Stage 1	23.0	1.03	7.41	1.3
	2	22.8	2.39	7.46	1.3
	3	22.3	2.92	7.81	1.3
	4	21.9	3.20	8.00	1.3
19 Nov	Influent	22.5	2.60	9.04	1.3
	Stage 1	22.2	2.20	7.45	1.3
	2	22.0	2.98	7.58	1.3
	3	21.4	4.70	7.89	1.3
	4	21.0	4.85	7.96	1.3
3 Dec	Influent	15.0	0.73	8.52	1.3
	Stage 1	12.3	0.59	7.72	1.3
	2	13.5	1.48	7.87	1.3
	3	12.6	2.14	7.94	1.3
	4	11.3	2.15	8.01	1.3
5 Dec	Influent	16.7	4.57	6.80	1.3
	Stage 1	16.0	3.49	7.33	1.3
	2	15.7	4.62	7.48	1.3
	3	14.9	6.20	7.56	1.3
	4	13.1	8.72	7.69	1.3
6 Dec	Influent	14.8	5.20	7.22	1.3
	Stage 1	13.2	4.26	6.96	1.3
	2	12.0	6.42	7.26	1.3
	3	9.7	8.25	7.62	1.3
	4	8.2	8.7	7.79	1.3
12 Dec	Influent	15.0	4.70	6.80	1.3
	Stage 1	14.7	0.90	6.38	1.3
	2	14.4	1.56	6.77	1.3
	3	14.1	2.80	7.31	1.3
	4	13.6	3.24	7.51	1.3

Table A-1 continued

Date	Sample Point	Temperature °C	DO mg/L	pH	Flow gal/min
18 Dec	Influent	15.6	1.16	6.59	1.3
	Stage 1				1.3
	2				1.3
	3				1.3
	4	11.8	0.42	6.55	1.3
19 Dec	Influent	14.4	8.10	6.03	1.3
	Stage 1				1.3
	2				1.3
	3				1.3
	4	14.0	7.95	6.68	1.3

TABLE A-2. RBC INFLUENT AND EFFLUENT PARAMETERS, CONVENTIONAL

Date	Sample	COD[a] mg/L	BOD mg/L	P mg/L	TKN mg/L	NH_3[a,b] mg/L
7 Jun	Infl	283				–
	Effl	156				
11 Jun	Infl	156				–
	Effl	30				
17 Jun	Infl	204				0.15
	Effl	49				
18 Jun	Infl	247				0.49
	Effl	22				0.52
19 Jun	Infl	272				0.17
	Effl	70				0.36
20 Jun	Infl	252				0.08
	Effl	41				0.17
21 Jun	Infl	257				0.11
	Effl	54				0.44
24 Jun	Infl	231				0.16
	Effl	23				0.69
25 Jun	Infl	185				0.15
	Effl	39				0.55
26 Jun	Infl	240				0.12
	Effl	70				0.58
27 Jun	Infl	327				0.21
	Effl	26				0.49
2 Jul	Infl	304				0.14
	Effl	40				0.58
3 Jul	Infl	341				0.09
	Effl	32				0.29
8 Jul	Infl	263				0.08
	Effl	39				0.55
9 Jul	Infl	270				5.42
	Effl	25				0.39
10 Jul	Infl	129				0.15
	Effl	44				0.67

Table A-2 continued

Date	Sample	COD[a] mg/L	BOD mg/L	P mg/L	TKN mg/L	NH_3[a,b] mg/L
16 Jul	Infl	274				0.20
	Effl	118				0.54
17 Jul	Infl	291				1.4
	Effl	37				0.47
18 Jul	Infl	251				5.0
	Effl	47				0.43
22 Jul	Infl	349				1.01
	Effl	33				
23 Jul	Infl	333				10.8
	Effl	37				0.84
24 Jul	Infl	243				2.25
	Effl	35				0.43
31 Jul	Infl	220				0.40
	Effl	39				0.52
2 Aug	Infl	215				0.20
	Effl	36				16.4
5 Aug	Infl	310				0.09
	Effl	35				0.33
6 Aug	Infl	235				0.35
	Effl	31				0.32
7 Aug	Infl	289				0.21
	Effl	21				0.29
8 Aug	Infl	408				0.13
	Effl	42				0.34
9 Aug	Infl	242				0.04
	Effl	15				0.31
12 Aug	Infl	288				0.07
	Effl	38				0.34
13 Aug	Infl	366				0.26
	Effl	41				0.49
14 Aug	Infl	252				0.15
	Effl	33				0.43

Table A-2 continued

Date	Sample	COD[a] mg/L	BOD mg/L	P mg/L	TKN mg/L	NH_3[a,b] mg/L
15 Aug	Infl	307				0.40
	Effl	43				0.56
20 Aug	Infl	224				0.22
	Effl	32				0.25
21 Aug	Infl	362				
	Effl	31				
22 Aug	Infl	218				-
	Effl	17				
23 Aug	Infl	203	132	0.93	0.7	0.21
	Effl	34	13	0.33	0.7	0.27
26 Aug	Infl	213	182	0.38	2.1	0.63
	Effl	22	9	0.37	0.5	0.42
27 Aug	Infl	288		0.49	2.1	0.37
	Effl	11		0.30	0.15	0.35
28 Aug	Infl	232	182			0.10
	Effl	22	1			0.30
29 Aug	Infl	406	123	0.34	2.1	0.12
	Effl	30	1	0.185	1.8	0.27
4 Sep	Infl	284	178	0.22	9.2	0.92
	Effl	40	1	0.21	4.0	0.54
5 Sep	Infl	343				0.45
	Effl	31				0.40
6 Sep	Infl	361	158	1.29	5.9	0.31
	Effl	26	1	0.97	3.9	0.31
9 Sep	Infl	340	91	0.51	4.9	0.24
	Effl	114	1	1.02	1.7	0.17
10 Sep	Infl	263				0.22
	Effl	21				0.16
11 Sep	Infl	162	186	0.12	7.8	0.24
	Effl	41	1	1.41	3.1	0.18
12 Sep	Infl	224	150	0.04	7.4	0.43
	Effl	36	1	0.10	3.9	0.17

Table A-2 continued

Date	Sample	COD[a] mg/L	BOD mg/L	P mg/L	TKN mg/L	NH_3[a,b] mg/L
16 Sep	Infl	259	231	0.14	7.3	0.42
	Effl	33		0.15	6.3	0.21
20 Sep	Infl	324	219	2.25	11.8	0.33
	Effl	55	1	2.05	4.8	0.05
23 Sep	Infl	274	168	0.62	9.5	0.59
	Effl	34	1	1.48	6.2	0.25
24 Sep	Infl	297				0.69
	Effl	28				0.27
25 Sep	Infl	213	140	1.36	7.1	0.91
	Effl	37	3	0.07	7.4	0.31
30 Sep	Infl	226	62	0.07	7.4	0.53
	Effl	56		0.20	5.7	0.26
1 Oct	Infl	232				0.47
	Effl	30				0.54
2 Oct	Infl	441	234	1.52	11.0	0.42
	Effl	26	4	1.28	6.2	0.33
3 Oct	Infl	474	182	1.56	8.0	2.2
	Effl	20	2	1.26	4.1	0.19
7 Oct	Infl	305	124	0.91	4.1	0.29
	Effl	61				0.17
8 Oct	Infl	233				0.53
	Effl	19				0.15
9 Oct	Infl	197	289	1.19	6.4	0.25
	Effl	49	2	1.16	5.0	0.13
10 Oct	Infl	271				0.22
	Effl	53				0.30
11 Oct	Infl	289	180	0.55	4.1	0.22
	Effl	44	30	0.96	11.9	0.30
14 Oct	Infl	290	210	1.00	3.8	
	Effl					
15 Oct	Infl	273				0.26
	Effl	70				0.18

Table A-2 continued

Date	Sample	COD[a] mg/L	BOD mg/L	P mg/L	TKN mg/L	NH_3[a,b] mg/L
16 Oct	Infl	402	247	1.16	4.0	
	Effl	22	5	.94	2.5	
21 Oct	Infl	258	237	1.23	2.1	0.39
	Effl	23	5	1.22	2.1	0.21
22 Oct	Infl	326				0.59
	Effl	39				0.62
23 Oct	Infl	165	115	0.38	2.7	
	Effl	11	4	0.43	2.2	
24 Oct	Infl	250	180	0.36	6.0	0.12
	Effl	12	11	0.09	2.7	0.71
25 Oct	Infl	264				0.08
	Effl	30				1.26
31 Oct	Infl	260	266	0.08	1.8	0.11
	Effl	39	3	0.94	5.7	1.38
1 Nov	Infl	245	118	0.14	3.4	0.13
	Effl	44	2	0.58	3.4	1.29
4 Nov	Infl	454	156	0.21	1.1	0.22
	Effl	13	3	1.05	2.9	0.68
5 Nov	Infl	359	138	0.29	3.5	0.45
	Effl	32	5	0.14	5.3	0.97
12 Nov	Infl	246	176	0.50	5.5	0.16
	Effl	25	24	0.06	6.3	0.81
14 Nov	Infl	290	132	1.06	3.8	
	Effl	22	1	0.46	1.8	
15 Nov	Infl	264				0.24
	Effl	27				0.19
18 Nov	Infl	299	216	0.12	9.7	0.41
	Effl	19	4	0.36	7.4	0.23
19 Nov	Infl	382				0.79
	Effl	23				0.29
2 Dec	Infl	264	115	0.27	13	
	Effl	35	4	0.06	7.3	

Table A-2 continued

Date	Sample	COD[a] mg/L	BOD mg/L	P mg/L	TKN mg/L	NH_3[a,b] mg/L
3 Dec	Infl	361				0.25
	Effl	46				0.19
5 Dec	Infl	220	191	1.82	10.5	1.59
	Effl	44	4	0.91	3.9	0.88
6 Dec	Infl	278				0.28
	Effl	49				1.26
12 Dec	Infl	302				0.42
	Effl	15				1.13
16 Dec	Infl	411				3.04
	Effl	144				1.78
18 Dec	Infl	374	100	0.68	6.0	
	Effl	119	21	0.21	4.3	
19 Dec	Infl	303	164	0.56	12.6	
	Effl	97	27	0.50	16.1	

a. Influent COD and NH_3 samples are taken every 8-hr shift at HSAAP; only those values corresponding to effluent samples are reported here.

b. Influent NH_3 was taken from the B-line, which is about 85% of the total flow to the neutralization basin.

TABLE A-3. RBC NITRAMINE LEVELS

Date	Sample Point	SEX mg/L	HMX mg/L	TAX mg/L	RDX mg/L
7 Jun	Influent	2.315	2.319	2.932	3.882
	Effluent	1.961	2.457	0.111	4.423
20 Jun	Influent	2.124	2.073	3.752	4.356
	Stage 1	1.827	1.480	1.635	1.277
	2	2.176	1.908	1.239	1.619
	3	2.267	1.856	0.804	1.701
	4	2.456	1.925	0.688	[illegible].672
25 Jun	Influent	2.636	1.748	4.185	6.057
	Stage 1	1.287	0.659	0.360	0.252
	2	2.221	1.688	0.597	2.892
	3	2.324	1.676	0.284	2.586
	4	2.493	1.739	0.167	2.606
27 Jun	Influent	2.275	2.944	3.502	4.184
	Stage 1	0.862	2.539	0.497	1.437
	2	0.759	2.454	0.429	1.256
	3	1.040	2.428	0.209	1.597
	4	1.326	2.343	0.129	1.784
10 Jul	Influent	1.327	1.980	2.473	5.182
	Stage 1	0.277	0.253	0.090	0.071
	2	0.774	1.200	<0.070	0.581
	3	0.755	1.404	<0.070	0.854
	4	0.491	0.150	<0.070	0.786
25 Jul	Influent	0.958	1.565	1.060	3.188
	Stage 1	1.246	2.394	<0.070	0.793
	2	1.239	2.443	<0.070	1.129
	3	1.192	2.492	<0.070	0.963
	4	1.076	2.582	<0.070	0.837
21 Aug	Influent	1.827	1.957	1.488	7.060
	Effluent	1.688	2.212	<0.07	4.660
22 Aug	Influent	1.788	1.663	0.882	4.880
	Effluent	1.230	1.738	<0.070	3.869
23 Aug	Influent	1.358	1.724	1.824	4.361
	Effluent	1.224	1.920	<0.070	4.538
26 Aug	Influent	0.965	1.917	2.487	6.353
	Effluent	1.140	2.014	<0.070	4.072
27 Aug	Influent	1.930	2.072	1.358	6.372
	Effluent	1.324	2.185	<0.070	3.574

Table A-3 continued

Date	Sample Point	SEX mg/L	HMX mg/L	TAX mg/L	RDX mg/L
28 Aug	Influent	2.848	1.728	1.527	4.606
	Effluent	1.462	2.070	<0.070	4.330
29 Aug	Influent	1.233	1.766	3.410	3.602
	Effluent	1.260	2.106	<0.070	4.120
4 Sep	Influent	1.090	1.760	2.364	7.427
	Effluent	1.519	2.345	0.074	4.894
5 Sep	Influent	1.974	1.713	4.616	6.298
	Effluent	1.424	2.288	<0.070	3.564
9 Sep	Influent	0.404	1.949	1.427	3.339
	Effluent	0.915	2.486	0.099	2.154
10 Sep	Influent	0.823	1.350	1.626	3.246
	Effluent	1.192	2.047	0.125	3.202
11 Sep	Influent	1.910	1.861	2.660	4.751
	Effluent	1.309	2.329	<0.070	3.866
12 Sep	Influent	0.806	1.734	3.737	4.747
	Effluent	1.014	2.122	0.157	6.901
16 Sep	Influent	1.419	2.309	3.451	4.302
	Effluent	1.113	2.223	0.141	4.104
20 Sep	Influent	0.789	2.016	1.655	3.989
	Effluent	1.275	1.955	0.108	4.197
23 Sep	Influent	1.024	2.016	2.792	3.444
	Effluent	1.345	2.327	<0.070	2.633
24 Sep	Influent	1.301	2.273	2.005	4.211
	Effluent	0.926	2.451	<0.070	3.352
25 Sep	Influent	1.046	1.813	1.762	3.498
	Effluent	0.886	1.990	<0.070	3.603
30 Sep	Influent	1.590	2.126	3.669	2.646
	Effluent	1.142	2.157	0.223	3.510
1 Oct	Influent	1.080	1.771	3.106	5.449
	Effluent	0.939	2.038	0.095	2.842
2 Oct	Influent	1.239	1.771	2.301	3.624
	Effluent	1.202	1.853	0.129	3.529

Table A-3 continued

Date	Sample Point	SEX mg/L	HMX mg/L	TAX mg/L	RDX mg/L
3 Oct	Influent	1.589	1.988	4.648	5.922
	Effluent	1.335	2.532	<0.070	3.518
7 Oct	Influent	1.295	1.979	2.548	5.186
	Effluent	1.303	1.944	<0.070	3.470
8 Oct	Influent	0.732	1.717	2.835	3.649
	Effluent	1.088	1.788	0.103	3.651
9 Oct	Influent	1.331	1.937	1.861	3.369
	Effluent	1.141	1.961	<0.070	3.782
10 Oct	Influent	1.257	1.920	1.837	3.023
	Effluent	1.175	1.999	<0.070	3.349
11 Oct	Influent	1.067	1.896	2.705	2.244
	Effluent	1.151	2.030	<0.070	2.790
14 Oct	Influent	1.256	1.792	3.421	5.114
	Effluent	1.279	2.288	<0.070	4.795
15 Oct	Influent	1.531	1.876	3.059	5.082
	Effluent	1.391	2.189	<0.070	4.229
16 Oct	Influent	1.319	1.928	3.026	4.157
	Effluent	1.218	2.237	0.111	3.612
21 Oct	Influent	0.376	1.659	1.169	9.870
	Effluent	0.372	1.910	0.149	5.916
22 Oct	Influent	2.657	1.665	<0.070	4.248
	Effluent	0.903	1.592	<0.070	2.298
31 Oct	Influent	1.529	1.999	1.219	4.334
	Effluent	1.822	1.664	<0.070	2.185
1 Nov	Influent	0.950	1.732	1.818	3.063
	Effluent	1.656	1.651	0.137	2.015
4 Nov	Influent	0.962	1.624	1.355	3.271
	Effluent	1.424	1.805	<0.070	2.235
5 Nov	Influent	1.620	1.590	3.645	5.179
	Effluent	1.398	1.656	0.235	4.034

Table A-3 continued

Date	Sample Point	SEX mg/L	HMX mg/L	TAX mg/L	RDX mg/L
12 Nov	Influent	1.483	1.617	4.717	4.760
	Effluent	1.437	1.723	0.024	2.992
15 Nov	Influent	1.342	1.633	3.339	5.097
	Effluent	1.587	1.953	<0.070	2.850
18 Nov	Influent	2.656	1.985	3.723	6.427
	Effluent	1.209	1.791	<0.070	2.296
19 Nov	Influent	0.815	1.740	1.782	4.521
	Effluent	1.978	1.863	<0.070	2.554
3 Dec	Influent	1.136	1.221	1.710	4.655
	Effluent	1.498	1.555	<0.070	3.247
6 Dec	Influent	0.978	0.255	0.995	2.414
	Effluent	1.500	1.482	<0.070	4.212
18 Dec	Influent	2.328	1.602	3.214	6.104
	Effluent	0.883	0.659	0.414	2.240
19 Dec	Influent	1.294	1.295	3.905	5.269
	Effluent	0.736	0.415	0.919	2.602

TABLE A-4. COMPOSITION OF SYNTHETIC MUNITIONS WASTEWATER

Component	Approximate Concentration[a], mg/L
Formaldehyde	674
Formic acid	218
Cyclohexanone	113
Acetic acid	82
1-Propanol	64
Acetone	54
Hexamine	44
Nitromethane	24
Methyl acetate	24
1-Propyl acetate	7
Toluene	4
Methylamine	2.5
Dimethylamine	2.5
Stearic acid[b]	2
Acetic anhydride[c]	31
TNT	12
RDX	11
HMX	2
Ammonium phosphate[d]	28
Ammonium sulfate[d]	98

a. Composition varies somewhat according to investigators; this is taken from reference 4.
b. Exceeds solubility.
c. The fate of acetic anhydride in this mixture is uncertain.
d. Does not include nutrients added to enhance biomass production.

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